DOCUMENT RESUME

ED 309 093 SE 050 749

TITLE Science Education: Common Curriculum Goals.
INSTITUTION Oregon State Dept. of Education, Salem.
PUB DATE Jul 88
NOTE 81p.; For related documents, see SE 050 745-750.
PUB TYPE Tests/Evaluation Instruments (160)

EDRS PRICE MF01/PC04 Plus Postage.
DESCRIPTORS Course Objectives; *Elementary School Science; Grade 3; Grade 5; Grade 8; Grade 11; High Schools; *Interests; Intermediate Grades; Junior High Schools; Middle Schools; Primary Education; Process Education; Psychomotor Skills; Science Curriculum; Science Education; *Scientific Concepts; *Secondary School Science; State Curriculum Guides; *Values
IDENTIFIERS *Oregon

ABSTRACT

The purpose of this booklet is to articulate the student outcomes expected for children at the end of grades 3, 5, 8, and 11. This document seeks to reflect the major themes of science education. These common curriculum goals have been developed not to detail separate facts of science needed to be taught by every science program, but to detail a larger view of the same subject around which the facts deemed important by each individual program can be organized. The concepts and processes of the seven common curriculum goals serve as the primary organizers, unifying Oregon's approach to the learning of K-12 science. The seven strands of this curriculum include: (1) concepts; (2) processes; (3) manipulative skills; (4) interests; (5) values; (6) interactions; and (7) characteristics. The student objectives in each content strand include the essential learning skills deemed appropriate for science instruction and the common knowledge and skills unique to science. Because concepts and processes are learned best in various contexts and in multiple experiences, they are pyramidical throughout the K-12 continuum. A brief list of resources is appended. (CW)

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SCIENCE EDUCATION

Common Curriculum Goals

September 1988

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Verne A. Duncan
State Superintendent of Public Instruction

Oregon Schools—A Tradition of Excellence

Adopted by the State Board of Education July 1988

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FOREWORD

In June 1984 the State Board of Education adopted the Oregon Action Plan for Excellence which established the direction for school improvement in the state over the next decade. The Action Plan drew upon the insights of teachers, administrators, school board members and community and business leaders.

A central concept of the Action Plan is that while the state will determine WHAT must be taught in public schools, the schools will determine HOW it will be taught. This document is intended to provide the essential information which local districts need to merge state curriculum expectations with their own local determinations for Science Education.

All who have joined in the spirit of the Action Plan for Excellence have shared a commitment to high-quality performance. We are continuing to learn about how to provide children with the very best in public education, and we welcome your comments and questions. For further information about this guide, contact the specialist for Science Education, 373-7898.

Verne A. Duncan
State Superintendent
of Public Instruction

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3224319884000

ACKNOWLEDGMENTS

Grateful acknowledgment is made to the following people for the many hours they have contributed to developing ideas and writing materials for this guide. They studied the literature, then shared their thinking and experiences as classroom teachers, as teachers of teachers at numerous inservice and preservice teacher education programs and various science personnel. School districts, colleges and various science agencies released these people to work on this publication.

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INTRODUCTION

THE OREGON ACTION PLAN FOR EXCELLENCE

The Action Plan identified seven areas of improvement, one of which called for a statewide definition of what students should learn:

> The Oregon Department of Education, working with local school districts and higher education institutions, shall define the required ***common curriculum goals*** for elementary and secondary schools in terms of the learning skills and knowledge students are expected to possess as a result of their schooling experience.
>
> Local school districts, with assistance from the Oregon Department of Education, shall be responsible for organizing the curriculum and delivering instruction to achieve the ***common curriculum goals***.

Common Curriculum Goals

The first stage in defining the Common Curriculum Goals was to develop the ***Essential Learning Skills*** — the basic skill and performance expectations for all students in the areas of reading, writing, speaking, listening, mathematics, reasoning and study skills. The second stage is to develop Common Knowledge and Skills in individual subject areas. Together with the ***Essential Learning Skills***, they form the Common Curriculum Goals for all students.

A. Essential Learning Skills

The ***Essential Learning Skills*** are considered basic to all students' learning, and all teachers are expected to provide instruction in these skills. Only to the degree that students develop these skills and form the habit of using them, can instruction in subject matter areas be successful. The skills are not specific to any one discipline but provide a link across all disciplines. Furthermore, the skills do not grow in isolation from content; they are strengthened through practice and use in all subject areas.

B. Common Knowledge and Skills

Looking beyond the ***Essential Learning Skills***, this document defines more fully what are considered to be the essentials in a strong Science Education program. Each district will want to extend and elaborate upon this base in order to create its own unique, comprehensive Science Education curriculum. Students should have the opportunity to demonstrate their achievement in a variety of ways. Equal opportunity to learn and the special needs of students are primary considerations in determining acceptable performance levels.

State Standards

The Common Curriculum Goals as presented in this document receive their authority from the Oregon State Standards for Public Schools, OAR 581-22-420 and 581-22-425. These rules were amended by the State Board of Education in January 1986.

PHILOSOPHY/RATIONALE UNDERLYING THIS CURRICULUM

Science is a process of building internally consistent conceptual models which help us make sense of the natural world. It looks for patterns and regularities to help us understand our environment. The process rests upon a cumulative base of interrelated ideas which help explain our observations of natural phenomena. It requires a questioning attitude and progresses by way of skills and processes such as collecting, organizing and interpreting information. Science involves challenging existing ideas and resolving

problems which arise when our ideas fail to explain all the "facts" we observe. Science by its very nature is an unfinished enterprise.

The rationale for including science as a critical component of the school curriculum in all grades is linked to the foregoing definition of science. At a personal level, competence in science gives individuals confidence to respond intelligently to objects and events of nature and to control some aspect of their personal environment and destiny. At a societal level, overall competence in science is necessary to assure stewardship of our planet and the human condition. Science education must help students to understand and, indeed, shape the ways in which science will affect the future quality of life. Why teach science? The major reason is to develop environmentally, scientifically, and technologically literate members of society.

There are recognized attributes that describe a scientifically and technologically literate person. Each attribute should be thought of as describing part of a continuum along which the individual may progress. The progress of the individual's science education should be equated with progress along this continuum. In 1972, Paul DeHart Hurd identified four major purposes of science education. The 1983 National Science Teachers Association position statement **Science-Technology-Society: Science Education for the 1980s** pushed for a new thrust in science education to emphasize goals which relate science to society and technology. Hurd's purposes are congruent with those of NSTA and Simpson, R.D. and Anderson, N.D., 1981, who describe their concept of the scientifically literate person:

- Has knowledge of the major concepts, principles, laws and theories of science and applies them in appropriate ways.
- Uses the processes of science in solving problems, making decisions and in other suitable ways.
- Understands the nature of science and the scientific enterprise.
- Understands the partnership of science and technology and its interaction with society.
- Has developed science-related skills that enable him or her to function effectively in careers, leisure activities and other roles.
- Has developed interests that will lead to a richer and more satisfying life and a life that will include science and life-long learning.

Clearly, scientific literacy cannot be pursued in isolation from other branches of thought and academic pursuit. Indeed, the strong relationships of science to language arts, mathematics, social studies and other areas indicate the value of integrated treatment of science with other curricular areas. The same "hands on" science activities that promote intellectual development during early school years simultaneously serve the development of reading, mathematical and social skills. Therefore, another answer to "Why teach science?" resides in the potential of science education to complement other curricular areas. This complementarity can exist through all school years. If carefully planned, integration of science with other subjects will also promote more efficient use of time in school.

In a world community which is increasingly competitive in producing scientific and technological goods and services, it is increasingly important to address ways in which science education may affect, directly and indirectly, both national concerns and individual career and leisure activities. Scientific literacy is needed for both the future scientists who will directly contribute to science nationally and internationally and the citizens who will indirectly shape the future course of science. A strong, sustained effort in science education is necessary to assure individual, national and international well-being.

The difficulties of improving and maintaining good science has led to the view that science education is in a state of crisis. By 1983, a wave of educational reform reports generated interest, support and funds for the improvement of education. In science, such studies clearly established that the average student using National

Science Foundation (NSF) curriculum materials of the 1960s outperformed 63% of the students in traditional textbook courses. Since current science teaching is marked by the almost total reliance on textbooks, reform efforts have again sought to identify programs which identify the fundamental knowledge, concepts and processes of science which make it accessible to all students.

As a result, this document seeks to reflect the major themes of current recommended science education. The Science Common Curriculum Goals have been developed not to detail separate particulate facts of science needed to be taught by every science program, but to detail a larger view of the same subject around which the facts deemed important by each individual program can be organized. The concepts and processes (CCGs 1.0 and 2.0) of the seven Science Common Curriculum Goals serve as the primary organizers, unifying Oregon's approach to the learning of K-12 science. Since the concepts and processes require personal development, teachers cannot teach them directly but must **facilitate** their development. Because they are also learned best in various contexts and in multiple experiences, they are pyramided throughout the K-12 continuum. **Concrete (hands-on) experiences** have been found critically important for almost all students in nearly all settings.

Because the concepts are not uniformly understood, teachers may want to begin their own instructional development with a set of Teaching Assistance in Scientific Concepts (TASC) papers which cover the concepts included in this document. The papers will be available from the Department of Education upon request. Each TASC paper is designed to introduce the concept and define it in teacher language using examples from contemporary curriculum. Sample test questions with a commentary on their appropriateness for measuring concept learning are also included.

Science education should be for all students. The science goals outlined in this document are consistent with the nature of the subject and the nature of all learners. This consistency means that students are learning science in ways that allow them to explore relationships and develop understandings. The fundamental premise on which this document is based is that every aspect of school science encountered by students should enhance their understanding of science, enabling them to become environmentally, scientifically and technologically literate citizens of the twenty-first century.

The Oregon Action Plan for Excellence established the direction for school improvement in this state, with the **Essential Learning Skills** document outlining the common skills to be addressed across all program areas for elementary and secondary education. This document, **Science: Common Curriculum Goals**, is written in relationship to that document as well as Oregon's **Framework for Science Programs** (1979) and the Science Common Knowledge and Skills.

Document Organization

In order to provide a curriculum consistent with the philosophy outlined above, the Common Curriculum Goals for Science have been organized into seven strands. They are as follows:

1.0 Concepts. Students apply an understanding of fundamental concepts on which science is based.

2.0 Processes. Students apply problem-solving and inquiry processes.

3.0 Manipulative Skills. Students use a variety of materials and equipment in a safe and scientific way.

4.0 Interests. Students develop interest in science.

5.0 Values. Students apply the values that underlie science.

6.0 Interactions. Students describe interactions among science, society, technology and the earth's environment.

7.0 Characteristics. Students describe the characteristics of scientific knowledge.

The student objectives in each content strand include both the Essential Learning Skills deemed appropriate for science instruc-

tion and the Common Knowledge and Skills unique to science. The Essential Learning Skills are referenced by citing their original identification numbers (e.g., ELS 6.4). Underlining marks the addition of the Common Knowledge and Skills of science and certain Essential Learning Skills when the wording has been significantly altered.

It is very important to remember that the student outcomes appearing in the columns headed Grade 3, Grade 5, Grade 8 and Grade 11 are expectancies for students to reach by the end of these grade levels. An expectancy appearing in the Grade 3 column, for example, represents a goal to be achieved as a result of four years of learning. Another Oregon Department of Education publication, "A Developmental Comprehensive Science Curriculum Model" is being developed and will suggest implementation strategies for each grade (K-12).

COMMON CURRICULUM GOALS

In order to provide a K-12 science curriculum consistent with the philosophy stated in the philosophy/rationale section of this document, the Common Goals for Science have been organized into seven strands.

Concepts

Students apply an understanding of fundamental concepts on which science is based. The concepts are organized for categories of events or objects.

There are at least two ways to identify and think about science concepts. One is idiosyncratically, i.e., the unifying concepts within each particular discipline or subject which undergird it. Another, is to identify concepts (e.g., cause and effect, change, cycle, energy-matter, organism, and population) which represents a minimal conceptual core of science knowledge. Each key concept can be viewed as a continuum along which the individual progresses as she/he learns more complex relationships (e.g., principles, laws) involving the concept.

GOAL 1.0: Concepts. Students apply an understanding of fundamental concepts on which science is based.

KNOWLEDGE/SKILLS	*GRADE 3*	*GRADE 5*	*GRADE 8*	*GRADE 11*
Students will be able to:				
1.1 **DEMONSTRATE *CAUSE AND EFFECT*: RELATED SERIES OF TWO OR MORE EVENTS THAT LEAD ONE TO BELIEVE THAT NATURE IS PREDICTABLE (E.G., ACID RAIN AFFECTING PLANT GROWTH, CHANGING THE TEMPERATURE OF A MATERIAL, CHEMICAL REACTIONS)***	[a]State possible causes for an observable event [b]Identify the relationship between a cause and an effect	[a]State a hypothesis using a cause and effect relationship [b]Identify the relationship between a cause and an effect	[a]State a hypothesis using a cause and effect relationship [b]Demonstrate an understanding of factors involved in a cause and effect relationship by predicting the outcome of interacting events [c]Identify relationships and regularities from which a general statement can be made about the effects of change (e.g., time increase increases reaction rate)	[b]Demontrate an understanding of factors involved in a cause and effect relationship by predicting the outcome of interacting events [c]Identify relationships and regularities from which a general statement can be made about the effects of change (e.g., time increase increases reaction rate)
1.2 **DEMONSTRATE *CHANGE*: THE PROCESS OF THINGS BECOMING DIFFERENT OVER TIME (E.G., AGING, GROWTH, METAMORPHOSIS, FIRE, MOUNTAINS BREAKING UP)** (ELS 6.1)**	[a]Demonstrate a physical change with simple objects	[a]Give examples of different rates of change [b]Explain how things continue to have some of the same characteristics even though a major change occurs	[a]Demonstrate physical and chemical changes [b]Explain how things or ideas can change when interacting with others [c]Describe linear and nonlinear rates of change [d]Distinguish between physical and chemical changes	[a]Relate various examples of change in an environment (e.g., biophysical, geophysical) [b]Defend conclusions, based on own previous observations or experiences, about interactions of two or more things or ideas

*The additional outcomes for science, both in the knowledge/skill column and the grade level expectancies, are in bold print to distinguish them from the Essential Learning Skills.
**Learning outcomes drawn from the ODE Essential Learning Skills document are cross-referenced by citing their original identifying number in parentheses. Any modification in the original wording is indicated by bold print.

GOAL 1.0: Concepts. Students apply an understanding of fundamental concepts on which science is based (continued).

KNOWLEDGE/SKILLS	GRADE 3	GRADE 5	GRADE 8	GRADE 11
1.3 DEMONSTRATE *CYCLE*: A PATTERN IN WHICH EVENTS OR CONDITIONS REPEAT AT REGULAR OR IRREGULAR INTERVALS (E.G., DAY AND NIGHT, SEASONS, REPRODUCTIVE CYCLES, NITROGEN AND CARBON CYCLES)	[a]Recognize a cycle		[a]Use cycles to explain relationships in the environment	[a]Describe various examples of cycles in the environment or within organisms
	[b]Arrange parts of a cycle	[b]Arrange parts of cycles		
	[c]Relate cycle to predictability	[c]Identify oscillation in a cycle	[c]Investigate ideas of recurrence and predictability	
1.4 DEMONSTRATE *ENERGY-MATTER*: MUTUALLY CONVERTIBLE EQUIVALENTS ("STUFF") FROM WHICH THE UNIVERSE IS MADE. MATTER CONTAINS ENERGY IN MANY FORMS (E.G., STATES OF MATTER ARE DETERMINED BY ENERGY IN MOTION, NUCLEAR ENERGY COMES FROM THE NUCLEUS WHEN ATOMS SPLIT OR FUSE)	[a]Identify states of matter and energy (e.g., solid, liquid, gas)	[a]Recognize the release of energy from matter (e.g., burning)	[a]Describe and demonstrate how technology utilizes the scientific tenets of the relationship between energy and matter (e.g., nuclear medicine, nuclear energy for producing electricity, electric motor)	[a]Describe and demonstrate how technology utilizes the scientific tenets of the relationship between energy and matter (e.g., nuclear medicine, active solar storage units, electric motor)
		[b]Recognize the converting of one energy form to another (e.g., mechanical rotation for transforming electricity)	[b]Define energy and matter	[b]Describe the relationship between energy sources and conversions
			[c]Recognize that the interaction of energy and matter determine the nature of the environment	
			[d]Describe the difference between renewable and nonrenewable resources	

GOAL 1.0: Concepts. Students apply an understanding of fundamental concepts on which science is based (continued).

KNOWLEDGE/SKILLS	GRADE 3	GRADE 5	GRADE 8	GRADE 11
1.5 DEMONSTRATE *ORGANISM*: A SYSTEM LIVING OR ONCE LIVING CHARACTERIZED BY THE PROCESSES OF LIFE (E.G., PLANTS AND ANIMALS: UNICELLULAR/BACTERIA)	[a]List characteristics of organisms that distinguish them from nonliving systems	[a]Identify the major life processes (e.g., digestion, locomotion, respiration, reproduction) that occur in an organism	[a]Demonstrate an understanding of the effect that one of the life processes (e.g., ingestion of food) has on another process (e.g., growth as a result of ingesting food)	[a]Measure the effect that one life process has on another (e.g., respiration on locomotion)
1.6 DEMONSTRATE *POPULATION*: A GROUP OF STRUCTURAL OR FUNCTIONAL UNITS THAT HAVE SPECIFIC OR COMMON CHARACTERISTICS (E.G., ORGANISMS)	[a]Identify characteristics which define and limit a given population (e.g., set of objects with exclusive characteristics)	[a]Identify and describe a population	[a]Describe how interaction and change affect individuals in populations and the populations themselves	[a]Use basic population dynamics to explain and predict current and future problems [b]Describe environmental effects and population interaction effects that result in predictable population changes
1.7 DEMONSTRATE *EQUILIBRIUM*: A STATE OF BALANCE OF EQUALITY BETWEEN OPPOSING FORCES (E.G., SEESAW, DIFFUSION OF MOLECULES FROM HIGH TO LOW CONCENTRATION) AFTER RATES REACH A BALANCED STATE		[a]Define and demonstrate balance	[a]Distinguish between static and dynamic forms of equilibrium [b]Demonstrate a state of equilibrium (e.g., a boat floating, hot air balloon in flight)	[a]Demonstrate an understanding of equilibrium in various settings (e.g., physical, biological, geological)

GOAL 1.0: Concepts. Students apply an understanding of fundamental concepts on which science is based (continued).

KNOWLEDGE/SKILLS	GRADE 3	GRADE 5	GRADE 8	GRADE 11
1.8 DEMONSTRATE *EVOLUTION*: A SERIES OF CHANGES THAT CAN BE USED TO EXPLAIN HOW SOMETHING HAS BECOME THE WAY IT IS OR TO PREDICT WHAT IT MIGHT BECOME (E.G., SIMPLE ANIMAL AND PLANT FORMS TO MORE COMPLEX FORMS)		[a]Recognize that evolution is the process of change over time [b]Identify adaptations of plant and animal parts	[a]Illustrate and experiment with different ways that things/objects (e.g., organisms, technology, automobile styles, geological features) change over time	[a]Identify, predict and experiment with the factors that relate to evolutionary change in a situation (e.g., organism, environment) [b]Distinguish between human-directed changes and natural processes (e.g., designed automobile styles vs. natural selection in living organisms)
1.9 DEMONSTRATE *FORCE*: A PUSH OR PULL AGAINST RESISTANCE WHICH CAUSES ACTION, INACTION OR CHANGE (E.G., CATAPULT, GRAVITY, CHANGE THE SPEED OR DIRECTION OF MOTION, STOP MOTION)		[a]Identify and change forces on an object	[a]Predict and explain the outcome of situations where forces interact (e.g., isometric exercises, isotonic solutions)	[a]Develop and explain a model which demonstrates the concept of force (e.g., lift on an airfoil, rocket's effect on direction of flight in outer space)
1.10 DEMONSTRATE *FUNDAMENTAL ENTITIES*: UNITS OF STRUCTURE AND FUNCTION USEFUL IN EXPLAINING PHENOMENA (E.G., ORGANISM IN POPULATIONS, METHODS OF MEASUREMENTS)		[a]Recognize basic units that make up objects and systems	[a]Use basic units which make up objects and systems	[a]Recognize and use appropriate fundamental units to explain structure and function of an object or system in an event

GOAL 1.0: Concepts. Students apply an understanding of fundamental concepts on which science is based (continued).

KNOWLEDGE/SKILLS	GRADE 3	GRADE 5	GRADE 8	GRADE 11
1.11 DEMONSTRATE *INTERACTION*: TWO OR MORE THINGS INFLUENCING EACH OTHER (E.G., POPULATION/FOOD, HOT/COLD, ACID/BASE, FORCE/MOVEMENT, VOLUME/PRESSURE)		[a]Recognize interactions by noting the object or condition that causes a change	[a]Use interactions to predict an outcome	[a]Identify levels of interactions within a complex system [b]Describe the relationship between variables in a system
1.12 DEMONSTRATE *ORDER*: THE TENET THAT THERE IS ORDER IN NATURE OR THAT ORDER CAN BE DESCRIBED IN THE VARIOUS SCHEMES OR PATTERNS OF NATURE (E.G., PERIODIC TABLE, TIDES, SUNRISE/SUNSET)		[a]Give examples of systems used to order objects or events (e.g., food chains)	[a]Order a given group of objects or common events by using one or more criterion	[a]Construct and use a dichotomous key which illustrates order
1.13 DEMONSTRATE *QUANTIFICATION*: A NUMBER AND UNIT RESULTING FROM A MEASUREMENT OF SOME REAL OR ABSTRACT THING, SITUATION OR EVENT (E.G., DISTANCE, TIME, MASS, METRIC SYSTEM (METER/SECOND/GRAM), DENSITY, SOLUBILITY, PROBABILITY)		[a]Collect and record data using appropriate units of measurement	[a]Create a pictorial or graphic representation of data	[a]Analyze data to draw conclusions and make predictions [b]Create appropriate data tables to collect and organize data [c]Demonstrate an understanding of measurement error (e.g., ±0.5)

GOAL 1.0: Concepts. Students apply an understanding of fundamental concepts on which science is based (continued).

KNOWLEDGE/SKILLS	*GRADE 3*	*GRADE 5*	*GRADE 8*	*GRADE 11*
1.14 DEMONSTRATE *SYSTEM*: A SET OF PARTS THAT FUNCTION TOGETHER AS A WHOLE. THE PARTS CAN BE DISCUSSED OR STUDIED INDIVIDUALLY FOR MORE EFFECTIVE LEARNING (E.G., PARTS OF A FLOWER, DIGESTIVE SYSTEM OF THE BODY, ELECTRIC MOTORS)		[a]Recognize and diagram the parts of a system	[a]Identify interactions between/among parts of a system [b]Identify input and output in a system [c]Diagram and explain the interrelationships of the components of common systems	[a]Examine systems to determine the effects of interaction between/among the parts
1.15 DEMONSTRATE *THEORY*: A PLAUSIBLE OR SCIENTIFICALLY ACCEPTABLE EXPLANATION MADE UP OF MODELS, CONCEPTS, AND PRINCIPLES OF SOME OBSERVED THING, PHENOMENON OR THOUGHT (E.G., DEVELOPMENT OF EARTH, ATOM, UNIVERSE)		[a]Define a theory	[a]Recognize that theories are tentative [b]Recognize examples of theories	[a]Use a theory to explain relationships between several objects or events [b]Evaluate strengths and weaknesses of various scientific theories
1.16 DEMONSTRATE *FIELD*: A REGION AROUND SOMETHING THAT INFLUENCES SOME OTHER THING OFTEN WITHOUT TOUCHING (E.G., MAGNETIC, ELECTRICAL, GRAVITATIONAL)			[a]Identify and describe a force field (e.g., magnetic field)	[a]Develop and explain a model which demonstrates the concept of field

GOAL 1.0: Concepts. Students apply an understanding of fundamental concepts on which science is based (continued).

KNOWLEDGE/SKILLS	*GRADE 3*	*GRADE 5*	*GRADE 8*	*GRADE 11*
1.17 DEMONSTRATE *GRADIENT*: A SITUATION IN WHICH THE INTENSITY OF SOMETHING INCREASES OR DECREASES IN A MORE OR LESS REGULAR PATTERN (E.G., TEMPERATURE CHANGES AS DISTANCE FROM HEAT SOURCE IS VARIED, STREAM FLOW, LIGHT INTENSITY CHANGES AS DISTANCE FROM LIGHT SOURCE IS VARIED)			[a]Describe the variations in a gradient	[a]Use concept of gradient to predict from existing data [b]Measure and graph the results of an experiment to illustrate gradient
1.18 DEMONSTRATE *INVARIANCE*: A CHARACTERISTIC OF AN OBJECT OR A SITUATION WHICH STAYS CONSTANT EVEN THOUGH OTHER CHARACTERISTICS MAY CHANGE (E.G., NUMBER OF PROTONS IN NUCLEUS, LIFE (TIME RELATED), TOTAL MASS IN CHEMICAL REACTION)			[a]Recognize and describe invariance in biological and physical systems	[a]Explain invariance in a system

GOAL 1.0: Concepts. Students apply an understanding of fundamental concepts on which science is based (continued).

KNOWLEDGE/SKILLS	*GRADE 3*	*GRADE 5*	*GRADE 8*	*GRADE 11*
1.19 DEMONSTRATE *MODEL*: PROPOSED IDEA OF THE COMPOSITION AND RELATIONSHIPS PRESENT IN SOMETHING THAT CANNOT BE OBSERVED DIRECTLY (E.G., BLACK BOX, BLACK HOLE)		[a]Recognize what a model is and why it is used (e.g., solar system)	[a]Use models to explain natural systems (e.g., plate tectonics) [b]Identify characteristics of all models	[a]Explain and evaluate a model [b]Use a model to make a prediction [c]Develop a model to explain the function or structure of a phenomenon
1.20 DEMONSTRATE *PERCEPTION*: THE MIND'S INTERPRETATION OF SENSORY INPUT (E.G., ILLUSIONS, USE OF SENSORY LIMITATIONS TO EXTEND PERCEPTION OF SCIENTIFIC EQUIPMENT)			[a]Describe things that change perception [b]Explain how perception may differ from person to person	[a]Describe and demonstrate how an instrument can be used to modify perception (e.g., microscope)
1.21 DEMONSTRATE *PROBABILITY*: AN EXPRESSION OF THE LIKELIHOOD THAT A SITUATION OR EVENT WILL OCCUR (E.G., FLIPPING COINS FOR HEADS OR TAILS, CARDS, NUMBERS, GENETICS, TYPES OF ORGANISMS, EARTHQUAKES, ELECTRON ORBITS)		[a]Explain how a number of data points influence probability	[a]Use data to recognize differences in predicted and actual outcomes [b]Explain the difference between high probability and certainty	[a]Apply basic principles of probability to predict outcome of events [b]Describe and illustrate statistical significance

GOAL 1.0: Concepts. Students apply an understanding of fundamental concepts on which science is based (continued).

KNOWLEDGE/SKILLS	GRADE 3	GRADE 5	GRADE 8	GRADE 11
1.22 DEMONSTRATE *REPLICATION*: REPEATING THE SAME CONDITION IN EXPECTATION THAT THE SAME RESULTS WILL BE PRODUCED (E.G., SAME SOIL CONDITION PRODUCES SAME SIZE PLANT, SAME INGREDIENTS IN SAME PRODUCT)		[a]Repeat a simple experiment	[a]Describe the importance of replication in experiments	[a]Design an experiment to replicate results [b]Explain why different individuals, doing the same experiment may not get the same results [c]Explain and use statistical means to evaluate accuracy and precision (e.g., standard deviation)
1.23 DEMONSTRATE *SCALE*: THE UNDERSTANDING THAT CHARACTERISTICS MAY CHANGE AS A SYSTEM'S DIMENSIONS ARE INCREASED OR DECREASED (E.G., MAPS, GLOBES, MODELS OF CARS OR PLANETS, OR HOUSES)		[a]Demonstrate proportion as an actual scaled size [b]Design a map drawing it to scale	[a]Explain the limitations of scale models used to represent natural phenomena (e.g., atom, solar system)	[a]Explain the change of a variable's effect on a system as a result of a change in scale [b]Predict changes that will occur as a result of change in scale
1.24 DEMONSTRATE *SYMMETRY*: STRUCTURALLY BALANCED (E.G., SNOWFLAKES, AIRPLANE BODY, RIGHT AND LEFT SIDE OF HUMAN BODY, SPHERE)		[a]Demonstrate bilateral and radial symmetry [b]Identify examples of symmetry found in the environment	[a]Relate types of symmetry to function in natural systems	[a]Demonstrate how symmetry in given situations relates to design and function [b]Discuss symmetry relative to growth patterns

GOAL 1.0: Concepts. Students apply an understanding of fundamental concepts on which science is based (continued).

KNOWLEDGE/SKILLS	*GRADE 3*	*GRADE 5*	*GRADE 8*	*GRADE 11*
1.25 DEMONSTRATE *TIME-SPACE*: THE TIMING OF AN EVENT MOVING FROM POINT A TO POINT B (E.G., MPH OR KM/H, AUTOMOBILES SEPARATED BY SPACE OF 3 SECONDS, VELOCITY OR VECTOR, SPEED OF NERVE IMPULSE)		[a]Demonstrate comprehension of the concept of movement	[a]Recognize and explain scales in measuring time and space [b]Demonstrate ability to use time and space to describe events (e.g., speed, relative position)	[a]Demonstrate ability to accurately time events during investigations [b]Demonstrate rate of change (e.g., speed, reaction rate, growth) [c]Graph time/space relationships

Processes

Students apply problem-solving and inquiry skills. The process skills of science are not independent of content. They are not merely "activity" in the name of "hands-on" science. The process skills are divided into basic processes (e.g., observe, measure, use numbers, classify, question, communicate) and integrated processes (e.g., design experiments, control variables, interpret data) providing foundations for more complex processes. The process skills are, in fact, interdependent with content and are used relationally, i.e., with objects or events.

GOAL 2.0: Processes. Students apply problem-solving and inquiry processes.

KNOWLEDGE/SKILLS	*GRADE 3*	*GRADE 5*	*GRADE 8*	*GRADE 11*
Students will be able to:				
2.1 ***OBSERVE*: MAKE ACCURATE OBSERVATIONS OF OBJECTS AND EVENTS USING THE SENSES OR INSTRUMENTS TO AID THE SENSES*** (ELS 4.1)**	**[a]Describe physical properties of objects observed by using the senses**	**[a]Describe changes observed in an object or event (e.g., metamorphosis of a Monarch butterfly, freezing water in a closed container)**	**[a]Distinguish the properties of objects directly or by manipulating or changing objects to observe their properties**	**[a]Separate pertinent observations from extraneous observations in an investigation**
	[b]Use simple instruments to enhance qualitative observations (e.g., hand lens, stethoscope)	**[b]Use instruments to enhance qualitative and quantitative observations of change within an object or an event (e.g., thermometer, camera, videotape, balance, computer)**	**[b]Use appropriate instruments to repeat and verify qualitative and quantitative observations in order to establish consistency**	**[b]Use appropriate instruments to refine quantitative and qualitative observations**
2.2 ***MEASURE*: USE MEASURING DEVICES TO COLLECT DATA** (ELS 1.7)	**[a]Compare objects to an arbitrary measuring device (e.g., comparing sticks of a varying length to one of a given length)**	**[a]Select and use the appropriate instrument for measurement in metric and English (U.S. Customary) units**	**[a]Select and use the appropriate instrument for measurement in metric and English (U.S. Customary) units**	**[a]Evaluate quantities that depend on more than one variable (e.g., density, pressure, velocity, momentum)**
	[b]Identify measurable properties (e.g., length, weight, mass, volume) of a given object	**[b]Measure and record the properties (e.g., length, weight, mass, volume, temperature, time) of an object or event**	**[b]Measure and record the properties (e.g., length, weight, mass, volume, temperature, time) of an object or event**	**[b]Identify limitations placed on an investigation by the measuring devices, senses, and techniques used**
				[c]Recognize the use of special scales in science which may be used in everyday life (e.g., Richter, pH)

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**Learning outcomes drawn from the ODE Essential Learning Skills document are cross-referenced by citing their original identifying number in parentheses. Any modification in the original wording is indicated by bold print.

GOAL 2.0: Processes. Students apply problem-solving and inquiry processes (continued).

KNOWLEDGE/SKILLS	GRADE 3	GRADE 5	GRADE 8	GRADE 11
2.3 ***USE NUMBERS***: USE NUMBER/NUMERIC FIGURES, LETTERS, WORDS, SYMBOLS AND VISUALS TO COUNT, COMPUTE AND COMMUNICATE QUANTITATIVE DATA (ELS 1.4)	[a]Use mental, manual, or calculator processes to perform grade-level arithmetic operations **in reporting scientific information and conducting scientific investigations**	[a]Use mental, manual, or calculator processes to perform grade-level arithmetic operations **in reporting scientific information and conducting scientific investigations** [b]Interpret **and construct tables and charts of scientific data** (ELS 1.6)	[a]Use mental, manual, calculator **and** computer processes to perform grade-level mathematical operations **in reporting scientific information and conducting scientific investigations** [b]**Interpret and construct graphs, charts, and tables of scientific data** (ELS 1.6)	[a]Use mental, manual, calculator **and** computer processes to perform grade-level mathematical operations **in reporting scientific information and conducting scientific investigations** [b]**Design tables, charts, and graphs to** show the relationship among variables (ELS 1.6)
2.4 ***RELATE TIME-SPACE***: **DESCRIBE SPATIAL RELATIONSHIPS AND THEIR CHANGE WITH TIME** (ELS 1.6)			[a]**Describe the location of an object relative to another object (e.g., reading and giving map directions)**	[a]**Describe spatial relationships and their change with time (e.g., velocity, acceleration)**
2.5 ***INFER***: RECOGNIZE, CONSTRUCT AND DRAW INFERENCES CONCERNING RELATIONSHIPS AMONG THINGS AND IDEAS (ELS 6.1)		[a]**Use a list of observations of an object or event (e.g., a spider building a web) to make an inference about the reason for or the function of the object or event)**	[a]**Develop a list of observations of an object or event and make logical inferences based on the observations** (ELS 6.4)	[a]**Develop alternative inferences from observations which could become hypotheses**

GOAL 2.0: Processes. Students apply problem-solving and inquiry processes (continued).

KNOWLEDGE/SKILLS	GRADE 3	GRADE 5	GRADE 8	GRADE 11
2.6 *CLASSIFY*: USE THE CHARACTERISTICS OF OBJECTS OR EVENTS TO GROUP THEM BY ORDERING SIMILARITIES (ELS 6.1)	[a]Identify general characteristics of objects which make them similar or different from another	[a]Classify objects according to specific characteristics	[a]Using a given scheme, classify objects or ideas according to patterns/multiple characteristics (ELS 1.6)	[a]Develop and use a classification system for organizing data
	[b]Sequence (seriate) objects using one variable (e.g., smallest to largest, gradation of a color) (ELS 1.6)	[b]Sequence (seriate) objects using one variable (ELS 1.6)	[b]Identify and sequence (seriate) data by value (ELS 1.6)	[b]Identify and sequence (seriate) data by value (ELS 1.6)
2.7 *DEFINE OPERATIONALLY*: USE THE COMMON CHARACTERISTICS OF SETS OF OBJECTS OR EVENTS OBSERVED OR EXPERIENCED TO DEVELOP DEFINITIONS OF THOSE OBJECTS OR EVENTS		[a]Develop a definition for a set from observations of members of the set (e.g., dogs)	[a]Observe related events (e.g., attraction between magnets and objects) and develop a definition for the concept shown (e.g., field)	[a]Use additional data to refine an operational definition
2.8 *QUESTION*: IDENTIFY PROBLEMS AND DEVELOP TESTABLE QUESTIONS RELATING TO THE PROBLEMS (ELS 6.3)	[a]Identify problems that need a solution	[a]Recognize information needed to solve a given problem	[a]Identify a problem and generate information necessary to understand the problem	[a]Identify a problem which may have a solution; generate and evaluate information critical to the solution of the problem
	[b]Identify alternative solutions to a simple problem	[b]Develop questions designed to clarify a given problem (ELS 2.3)	[b]Develop testable questions designed to clarify the problem (ELS 2.3)	[b]Develop testable questions which may contribute to the solution of a problem (ELS 2.3)
	[c]State questions relating to an object or event (ELS 2.3)	[c]Use data from the questioning process to develop a problem-solving plan		

GOAL 2.0: Processes. Students apply problem-solving and inquiry processes (continued).

KNOWLEDGE/SKILLS	*GRADE 3*	*GRADE 5*	*GRADE 8*	*GRADE 11*
2.9 ***HYPOTHESIZE*: USE INFORMATION AND QUESTIONS TO GENERATE STATEMENTS THAT DESCRIBE EXPECTED RESULTS OF INVESTIGATION** (ELS 6.2)			**[a]Use information and questions to generate statements that describe expected results of investigations**	**[a]Use information and questions to generate testable hypotheses** **[b]Differentiate hypotheses that can be tested quantitatively from those that are limited to qualitative tests**
2.10 ***DESIGN EXPERIMENTS*: PLAN AND CONDUCT DATA GATHERING OPERATIONS TO TEST HYPOTHESES OR ANSWER QUESTIONS** (ELS 6.3)		**[a]Follow directions to conduct an experiment and identify the hypothesis used**	**[a]Gather and organize data that may be used in testing a hypothesis**	**[a]Design a procedure to test a hypothesis**
	[b]Solve problems using strategies such as guessing and checking, using concrete objects, making models, generating a pattern or drawing a picture	[b]Solve problems using a variety of strategies such as guessing and checking, making predictions based upon a pattern, making a drawing or model	[b]Solve problems using appropriate strategies such as guessing and checking, making a systematic list, looking for patterns, making or drawing a model, eliminating possible answers or solving a simpler problem	[b]Select and apply the most appropriate tools, methodologies, processes and operations in solving a variety of problems
	[c]Engage in cooperative problem-solving and common alternative solution strategies	[c]Engage in cooperative problem-solving and compare alternative solution strategies	[c]Engage in cooperative problem-solving and compare alternative solution strategies	[c]Engage in cooperative problem-solving and compare alternative solution strategies
	[d]Develop new suggestions or approaches if problem is not solved	[d]Use formative (in process) data to modify or confirm problem-solving plan	[d]Use summative (final) data to determine if the problem-solving approach was successful, and if not, how it should be modified	[d]Analyze the formative and summative data to confirm or revise the proposed solution

GOAL 2.0: Processes. Students apply problem-solving and inquiry processes (continued).

KNOWLEDGE/SKILLS	GRADE 3	GRADE 5	GRADE 8	GRADE 11
2.11 *CONTROL VARIABLES*: IDENTIFY AND MANAGE FACTORS THAT MAY INFLUENCE AN EXPERIMENT (ELS 3.1)		[a]Identify factors that may influence the outcome of an investigation	[a]Distinguish between controlled variables and variables which are being tested in an experiment	[a]Design methods for controlling selected variables
		[b]Draw logical conclusions from information presented	[b]Draw logical conclusions from information presented	[b]Synthesize information and draw conclusions
2.12 *INTERPRET DATA*: FIND PATTERNS OR MEANINGS IN EXPERIMENTAL RESULTS (ELS 3.1, 6.2, and 6.4)	[a]State similarities in observations of several identical demonstrations or investigations (ELS 6.2)	[a]Inspect data tables or charts to find systematic changes in a variable	[a]Use the results of analyzing data (e.g., classifying, inferring, using numbers) to interpret the meaning and significance of an investigation (ELS 6.2)	[a]Recognize a pattern or other meaning inherent in a collection of data which leads to stating a generalization or developing a hypothesis
		[b]Evaluate whether a simple written or oral inference is consistent with known data (ELS 6.4)	[b]Compare the results of experiment data analysis to the expected results and determine the reasons for the differences (ELS 6.4)	[b]Interpret discrepancies or correspondence between anticipated results (hypotheses) and actual results of an investigation they have performed (ELS 6.2)
		[c]Draw logical conclusions from information presented (ELS 3.1)	[c]Draw logical conclusions from information presented (ELS 3.1)	[c]Synthesize information and draw conclusions (ELS 3.1)
2.13 *PREDICT*: USE INFORMATION AND DATA TO GENERATE AND TEST PREDICTIONS (ELS 1.6 and 6.2)	[a]Use observations already made, to predict new observations (e.g., if a candle flame is extinguished when covered by a jar 3 times, it should go out when covered a fourth time) (ELS 6.2)	[a]Make predictions based on the systematic changes found in a data table or chart (e.g., use the chart to predict the time a burning candle would be extinguished in a closed container) (ELS 1.6)	[a]Use quantitative measurement as a means of improving accuracy of predictions (ELS 1.6)	[a]Establish confidence levels for accepting or rejecting predictions (ELS 1.6, 3.1 and 6.2)

GOAL 2.0: Processes. Students apply problem-solving and inquiry processes (continued).

KNOWLEDGE/SKILLS	*GRADE 3*	*GRADE 5*	*GRADE 8*	*GRADE 11*
2.14 ***FORMULATE MODELS***: **USE PROBLEM-SOLVING AND QUESTIONING SKILLS TO DEVELOP MENTAL MODELS THAT EXPLAIN PHENOMENA** (ELS 6.3)			[a]**Create verbal and visual representations of an object, system or event which cannot be directly observed (e.g., interior structure of the earth)**	[a]**Describe a closed interacting system based on observation and tests (e.g., a closed box system)** [b]**Use simulations to show changes in demographics (e.g., computer models, change in populations)**
2.15 ***COMMUNICATE***: USE A VARIETY OF TECHNIQUES TO **SHARE THE RESULTS OF INVESTIGATIONS** (ELS 1.6 and 2.3)	[a]**Share information orally and pictorially about investigations** (ELS 2.3)	[a]**Share information about investigations by applying oral, written and visual (e.g., graphs) communication skills** (ELS 1.6 and 2.3)	[a]**Share information about investigations through oral, written, and visual (e.g., graphs, charts) communication skills** (ELS 1.6 and 2.3)	[a]**Present and explain the results of investigations to groups, using oral, written, and visual (e.g., graphs, charts) communication skills** (ELS 1.6 and 2.3)

Manipulative Skills

Students use a variety of materials and equipment in a safe and scientific way. The practice of appropriate and positive safety behaviors will enhance learning while students construct equipment or apparatus necessary for scientific activities. Student-developed activities can provide students with an opportunity to experience a concept through invention and discovery lessons.

GOAL 3.0: Manipulative Skills. Students use a variety of materials and equipment in a safe and scientific way.

KNOWLEDGE/SKILLS	*GRADE 3*	*GRADE 5*	*GRADE 8*	*GRADE 11*
Students will be able to:				
3.1 ***CONSTRUCT*: SET UP, SHAPE OR BUILD THE EQUIPMENT AND APPARATUS NECESSARY FOR SCIENTIFIC ACTIVITIES (E.G., GRID SQUARES, MICROSCOPE SLIDES, GLASSWARE)***	[a]Build model parts of the environment (e.g., trees, mountains, buildings, school playground)	[a]Select and assemble materials (e.g., bird houses, feeders, insect displays, rearing chambers, models)	[a]Select, assemble, or construct equipment or apparatus to conduct a science activity	[a]Select, assemble, or construct equipment or apparatus to conduct a science activity
3.2 ***HANDLE MATERIALS*: DEMONSTRATE THE PROPER SAFE USE AND MAINTENANCE OF LABORATORY EQUIPMENT AND MATERIALS (E.G., POINTED SCISSORS, SAFETY GLASSES, MICROSCOPES, CHEMICALS, POWER TOOLS, LIVING MATERIALS, MODELS, MEASURING DEVICES)**	[a]Describe cause and effect relationships in safety procedures	[a]Develop an awareness of handling and disposal of hazardous materials and equipment [b]Develop rules establishing safe hands-on experimental practices	[a]Use proper techniques when handling equipment and disposing of hazardous materials [b]Use appropriate safety equipment (e.g., clothes, eye protection, hearing protection, fire control equipment) [c]Demonstrate proper technique for common laboratory skills (e.g., heating, filtering, using a balance)	[a]Use proper techniques when handling equipment and disposing of hazardous materials [b]Use appropriate safety equipment (e.g., clothes, eye protection, hearing protection, fire control equipment) [c]Demonstrate proper technique in use of all laboratory apparatus (e.g., microscope, buret, electronic balance, voltmeter)

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GOAL 3.0: Manipulative Skills. Students use a variety of materials and equipment in a safe and scientific way (continued).

KNOWLEDGE/SKILLS	*GRADE 3*	*GRADE 5*	*GRADE 8*	*GRADE 11*
3.3 ***PRACTICE BEHAVIOR***: PRACTICE APPROPRIATE AND POSITIVE HEALTH BEHAVIORS TO ENHANCE LEARNING (ELS 7.4)**		[a]Explain how substance use can produce healthful or harmful effects on mental and physical performance **(e.g., gathering data during an investigation)**	[a]Evaluate the effects of substance use on physical and mental performance **(e.g., recording accurate measurements during an investigation)**	[a]Apply information and skills concerning substance use which will enhance physical and mental performance **(e.g., using laboratory measuring devices, handling chemicals)**

Learning outcomes drawn from the **ODE Essential Learning Skills document are cross-referenced by citing their original identifying number in parentheses. Any modification in the original wording is indicated by bold print.

Interests

Students develop interest in science. Student interest in science is enhanced when participation in and understanding scientific things at the students' own level of sophistication leads to gaining confidence.

Learning from many sources (e.g., reading, watching, visiting); wanting and giving scientific explanations by preferring systematic and exact explanations to nonscientific ones, if the former are at the appropriate levels of sophistication; finding avocations (e.g., photography, shell collecting, constructing apparatus) that are rewarding; and exploring vocations when considering science-related careers, all can contribute significantly to the development of the students' interest in science.

GOAL 4.0: Interests. Students develop interest in science.

KNOWLEDGE/SKILLS	GRADE 3	GRADE 5	GRADE 8	GRADE 11
Students will be able to:				
4.1 DEVELOP VOCATIONAL AND AVOCATIONAL INTERESTS IN SCIENCE BY USING MANY SOURCES (E.G., MEDIA, ORGANIZATIONS, CONDUCTING OWN RESEARCH ACTIVITY IN AND BEYOND THE CLASSROOM)* (ELS 7.2)**	[a]Locate and use reference materials (e.g., books, periodicals, newspaper, observations of nature, television, museums, exhibits, personal interviews)	[a]Locate and use reference materials (e.g., books, periodicals, newspaper, observations of nature, television, museums, exhibits, personal interviews, computer accessed data bases)	[a]Locate and use reference materials (e.g., books, periodicals, newspaper, observations of nature, television, museums, exhibits, personal interviews, computer accessed data bases)	[a]Locate and use reference materials (e.g., books, periodicals, newspaper, observations of nature, television, museums, exhibits, personal interviews, computer accessed data bases)
		[b]Use library classification system and services to locate specialized resources	[b]Use library classification system and services to locate specialized resources (e.g., people with expertise, print and nonprint, places of interest and information)	[b]Use library classification system and services to locate specialized resources (e.g., people with expertise, print and nonprint, places of interest and information)
		[c]Describe several science vocations and avocations	[c]Identify aspects of science which relate to vocational and avocational interests	[c]Identify science courses and resources which will enhance vocational and avocational interests
4.2 RECOGNIZE WORDS AND SYMBOLS COMMONLY USED IN WRITTEN MATERIALS (ELS 1.1)		[a]Recognize common words and symbols found in written materials	[a]Recognize common words and symbols found in written materials	[a]Recognize common words and symbols found in written materials
				[b]Define operationally common science terms related to science concepts

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GOAL 4.0: Interests. Students develop interest in science (continued).

KNOWLEDGE/SKILLS	GRADE 3	GRADE 5	GRADE 8	GRADE 11
4.3 DETERMINE MEANING OF UNKNOWN WORDS **AND SYMBOLS** COMMONLY USED IN **INSTRUCTIONAL MATERIALS** (ELS 1.2)	[a]**Use concrete (hands-on) experiences as a basis for determining meaning of terms**	[a]**Use concrete (hands-on) experiences as a basis for determining meaning of terms**	[a]**Use concrete (hands-on) experiences as a basis for determining meaning of terms**	[a]**Use concrete (hands-on) experiences as a basis for determining meaning of terms**
	[b]Use dictionaries, glossaries, **media, and other reference materials to find word and symbol meanings**	[b]**Use dictionaries, glossaries, media, and other reference materials to find word and symbol meanings**	[b]Use dictionaries, glossaries, **media**, and other reference materials to find word **and symbol** meanings	[b]Use **standard and scientific** dictionaries, glossaries, **handbooks** and definitions in footnotes to find word meanings
			[c]**Utilize affixes and root words in understanding meaning of scientific and technological terms**	[c]**Utilize affixes and root words in understanding meaning of scientific and technological terms**
4.4 USE INSTRUCTIONAL MATERIALS AS BASIS FOR GAINING KNOWLEDGE AND IMPROVING COMPREHENSION (ELS 2.2)	[a]Use table of contents to locate general and specific information	[a]Use table of contents and index to locate general and specific information	[a]Use table of contents, index, summaries, charts, graphs, and illustrations to locate information needed	[a]**Use and interpret a variety of written resources (e.g., charts, graphs, tables) to locate information needed**
		[b]Use supportive illustrations, detail and summations to obtain information	[b]Use organization of materials (summaries, headings and review questions) for preview and review	[b]Use organization of materials (summaries, headings and review questions) for preview and review
		[c]**Use current technology (e.g., videotape, computer accessed data bases, video disc) to locate information needed**	[c]**Use current technology (e.g., videotape, computer accessed data bases, video discs) to locate information needed**	[c]**Use current technology (e.g., videotape, computer accessed data bases, video discs) to locate information needed**

Values

Students apply values that underlie science. By directing inquiry toward knowledge as a worthy investment of time and other resources, knowing and understanding will be valued. Questioning all things, searching for data and meaning, demanding verification, respecting logic, and considering the consequences of actions to be taken are values that students of science will be able to apply.

GOAL 5.0: Values. Students apply the values that underlie science.

KNOWLEDGE/SKILLS	GRADE 3	GRADE 5	GRADE 8	GRADE 11
Students will be able to:				
5.1 **RECOGNIZE THAT SEEKING KNOWLEDGE AND UNDERSTANDING IS A WORTHY INVESTMENT OF TIME AND RESOURCES*** (ELS 6.2 and 6.3)**	**[a]Share information and understanding with others**	**[a]Evaluate new information**	**[a]Recognize the importance of securing and evaluating information**	**[a]Apply knowledge and understanding in new situations**
	[b]Explain the importance of information obtained through personal experience	**[b]Evaluate personal knowledge and knowledge of others**	**[b]Evaluate the worth of information needed to make decisions**	**[b]Analyze explanations and interpretations to confirm or validate them**
	[c]Explain the importance of information obtained from others		[c]Interpret differences between two explanations (ELS 6.2)	
5.2 **QUESTION INFORMATION AND IDEAS BY DETERMINING THEIR** SIGNIFICANCE AND ACCURACY AS PRESENTED IN WRITTEN, ORAL, AURAL AND VISUAL COMMUNICATIONS (E.G., LISTENING, READING, VIEWING, EVALUATING PRESENTATIONS OF MASS MEDIA) (ELS 4.4 and 6.4)		**[a]Distinguish between relevant and irrelevant information used to draw conclusions**	**[a]Distinguish between relevant and irrelevant information used to draw conclusions**	**[a]Distinguish between relevant and irrelevant information used to draw conclusions**
		[b]Determine a strategy for determining whether a statement is a fact (ELS 6.4)	**[b]Analyze information obtained through personal experience**	[b]Critically evaluate arguments or positions in terms of known facts (ELS 6.4)
		[c]Evaluate whether a simple written or oral conclusion is consistent with known facts	**[c]Analyze information obtained by others**	**[c]Evaluate the significance and accuracy of information**

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GOAL 5.0: Values. Students apply the values that underlie science (continued).

KNOWLEDGE/SKILLS	GRADE 3	GRADE 5	GRADE 8	GRADE 11
			[d]Evaluate whether a conclusion is based on evidence or opinion (ELS 6.4)	[d]**Distinguish between nonscience and the unknown or unanswerable**
			[e]**Listen, read and view critically**	[e]Listen, read and view critically (ELS 4.4)
			[f]Recognize elements and identify influences of mass media upon self and society (ELS 4.4)	[f]Evaluate roles of mass media in society (ELS 4.4)
			[g]Critically evaluate mass media influences (ELS 4.4)	
			[h]**Identify appropriate types of information (e.g., qualitative, quantitative) that should be included in simple forms of communication**	[h]**Identify appropriate types of information (e.g., qualitative, quantitative) that should be included in simple forms of communication**
			[i]**Evaluate whether a simple written or oral conclusion is consistent with known facts**	[i]**Evaluate whether a simple written or oral conclusion is consistent with known facts**
			[j]Recognize persuasion techniques found in audio and visual communications (ELS 4.4)	[j]Recognize elements and use of propaganda techniques found in audio, printed and visual communications (ELS 4.4)

GOAL 5.0: Values. Students apply the values that underlie science (continued).

KNOWLEDGE/SKILLS	GRADE 3	GRADE 5	GRADE 8	GRADE 11
5.3 RECOGNIZE THE IMPORTANCE OF SYSTEMATICALLY ACQUIRING AND ORDERING DATA AS THE BASIS FOR SCIENTIFIC EXPLANATIONS AND THEORIES (ELS 6.4)		[a]Recognize the relationship between the data acquired and scientific explanation or theory (e.g., give examples of real data which support an explanation or theory)	[a]Distinguish between scientific and nonscientific explanations	[a]Recognize the need for systematic and exact explanation over a nonscientific explanation [b]Explain the value of data in supporting a scientific explanation
5.4 RECOGNIZE THAT SCIENTIFIC EXPLANATIONS MUST BE REPLICABLE (E.G., SUPPORTING EVIDENCE OBTAINED BY OTHER INVESTIGATORS WORKING IN DIFFERENT PLACES AT DIFFERENT TIMES UNDER SIMILAR CONDITIONS) AND MADE PUBLIC IN ORDER TO BE ACCEPTED AS VALID (ELS 5.3)		[a]Use data collected from other students to verify their own results in an investigation	[a]Verify data collected from other students by replicating an investigation and comparing the results	[a]Seek ways of verifying ideas through experimentation and research [b]Evaluate, on an ongoing basis, the strengths and weaknesses of ideas and theories based on new information [c]Explain the importance of validation of scientific explanations and possible consequences if this did not occur

GOAL 5.0: Values. Students apply the values that underlie science (continued).

KNOWLEDGE/SKILLS	GRADE 3	GRADE 5	GRADE 8	GRADE 11
5.5 APPLY LOGIC BY REFLECTING UPON AND IMPROVING OWN REASONING (ELS 6.6)	[a]Describe in simple terms how a solution was reached	[a]Describe the reasoning process most frequently being used in terms of inductive or deductive reasoning [b]State rationale for people having biases [c]Identify authoritative sources for obtaining feedback about reasoning **skills**	**[a]Use inductive and deductive reasoning given problems and data specific to each form of logic** [b]Explain personal biases	[a]Present arguments supporting the use of deductive or inductive reasoning for a particular purpose [b]Evaluate when bias, inconsistency or other weaknesses affect reasoning [c]Defend position when criticized by an authority who is biased
5.6 RECOGNIZE THE IMPORTANCE OF CONSIDERING THE CONSEQUENCES (E.G., POSSIBLE, ACTUAL) OF INVESTIGATIONS AND ACTIONS BEFORE DECIDING TO CONTINUE, CHANGE, OR STOP THE PROCESS		**[a]Recognize consequences of own personal choices**	**[a]Trace consequences of human intervention in natural cycles**	**[a]Evaluate the consequences of action taken** **[b]Recognize the value of predicting consequences of action taken** **[c]Determine if action should continue with a given scientific study after considering the possible consequences (e.g., hydrogen nuclear fission, genetic engineering, human clothing)**

Interactions

Students describe interactions among science, society, technology and earth's environment. Societies influence what science investigates and technology develops; society — including scientists and technologists — ultimately determines how science is applied. Science's influence is exerted when scientists open-mindedly and steadfastly investigate what society may **think** irrelevant or trivial, though it may take time for society to realize the benefits; even when realized, some benefits may have undesirable side effects, trade-offs.

Scientists, technologists and educators owe the public clear and timely information; the public in turn needs to pay attention, to question and to realize scientists may disagree because they interpret data differently.

Due to the limitations of science, science cannot solve all of society's problems; solutions may be impossible, some may defy scientific methods, none can be legislated, bought or guaranteed.

GOAL 6.0: Interactions. Students describe interactions among science, society, technology and earth's environment.

KNOWLEDGE/SKILLS	*GRADE 3*	*GRADE 5*	*GRADE 8*	*GRADE 11*
Students will be able to:				
6.1 DESCRIBE HOW SOCIETY INFLUENCES SCIENCE AND TECHNOLOGY*		[a]Identify technology which has been developed or improved because people wanted it (e.g., styrofoam cups)	[a]Recognize demands of society which influence science and technology	[a]Describe how society's support influences science and technology
		[b]Identify technology which has been developed or improved to help people (e.g., kidney dialysis machine)	[b]Recognize that society controls science and technology through the allocation of resources	[b]Describe why it can be important for society to support pure scientific research which has no apparent or immediate application, but simply seeks to find answers to questions or test hypotheses
6.2 DESCRIBE HOW SCIENCE AND TECHNOLOGY INFLUENCE SOCIETY	[a]Identify technology that is used and how it helps society	[a]Recognize how individual wants and needs are positively and negatively influenced by scientific knowledge	[a]Recognize how scientific knowledge influences societies' attitudes	[a]Identify examples of how scientific knowledge has helped in the solution of societal problems
		[b]Recognize how individual wants and needs are influenced by technology	[b]Recognize how individual wants and needs are positively and negatively influenced by technology	[b]Recognize how individual wants and needs are positively and negatively influenced by technology
			[c]Identify scientific and technological developments which have positively and negatively affected society	[c]Describe specific scientific and technological developments and how they have positively affected society

*The additional outcomes for science, both in the knowledge/skill column and the grade level expectancies, are in bold print to distinguish them from the Essential Learning Skills.

GOAL 6.0: Interactions. Students describe interactions among science, society, technology and earth's environment (continued).

KNOWLEDGE/SKILLS	GRADE 3	GRADE 5	GRADE 8	GRADE 11
6.3 RECOGNIZE THE LIMITATIONS AS WELL AS THE USEFULNESS OF SCIENCE AND TECHNOLOGY IN ADVANCING HUMAN WELFARE		[a]Recognize that all consequences of science cannot be anticipated	[a]Recognize the physical factors that limit science (e.g., things that cannot be measured or observed) [b]Identify social problems which can and cannot be solved by scientific and technological advances (e.g., vaccines to prevent disease, human greed)	[a]Recognize that data is being generated faster than it can be applied [b]Predict ways in which science and technology may advance human welfare
6.4 DESCRIBE AND PREDICT THE EFFECTS OF SCIENCE, SOCIETY AND TECHNOLOGY ON THE EARTH'S ENVIRONMENT AND ITS ABILITY TO SUPPORT ALL FORMS OF LIFE	[a]Identify the basic environmental needs of humans and other organisms (e.g., plants, animals)	[a]Describe how specific scientific and technological advances have affected the earth's environment and its ability to support life (e.g., sewage treatment plants, automobile exhaust, pesticides)	[a]Describe how specific scientific and technological advances have affected the earth's environment and its ability to support life (e.g., sewage treatment plants, automobile exhaust, pesticides) [b]Compare the effects of specific scientific and technological advances which have changed the earth's environment (e.g., automobiles, fertilizers)	[a]Describe how specific scientific and technological advances have affected the earth's environment and predict how continued use or development may affect humans and other organisms [b]Describe the difficulties involved in predicting the environment changes associated with scientific and technological advances

GOAL 6.0: Interactions. Students describe interactions among science, society, technology and earth's environment (continued).

KNOWLEDGE/SKILLS	*GRADE 3*	*GRADE 5*	*GRADE 8*	*GRADE 11*
6.5 **EVALUATE THE EXPLANATIONS BY SCIENTISTS, NEEDS OF SOCIETY AND POSSIBLE IMPACTS ON THE EARTH'S ENVIRONMENT TO MAKE RESPONSIBLE PERSONAL DECISIONS REGARDING THE USES OF TECHNOLOGY** (ELS 6.4 and 6.5)**			[a]**Describe the applications of technology and the decisions entailed in its use**	[a]**Describe applications of technology and decisions entailed in its use**
			[b]**Identify reliable sources of scientific and technological information and use these sources in deciding a course of action**	[b]**Analyze authoritative data to determine what optional positions are possible on a specific issue**
		[c]State personal criteria for deciding whether to engage in **or support** a particular activity (ELS 6.4)	[c]State societal criteria for deciding whether to engage in **or support** a particular activity (ELS 6.4)	[c]Assess the worth of a given course of action or policy **after considering its possible impacts on individual, society and the earth's environment** (ELS 6.4)
			[d]Take a position on an issue based on **available information** (ELS 6.5)	[d]Formulate, support and defend a position based upon data gathered from objective and authoritative sources (ELS 6.5)
			[e]Support another person's position on an issue **(e.g., through role playing, structured controversy techniques)** (ELS 6.5)	[e]Support another person's position on an issue **(e.g., through role playing, structured controversy techniques)** (ELS 6.5)

Learning outcomes drawn from the **ODE Essential Learning Skills document are cross-referenced by citing their original identifying number in parentheses. Any modification in the original wording is indicated by bold print.

Characteristics

Students describe the characteristics of scientific knowledge. Science is tentative since it is subject to change. It is not truth in an absolute and final sense.

Science is also public because other individuals could arrive at similar conclusions when confronted with the same evidence. It is replicable since other investigators working in different places at different times can gather similar evidence given similar conditions. Science is empirical because it tests hypotheses by experiment and observation after collecting data exactly, systematically, and objectively.

GOAL 7.0: Characteristics. Students describe the characteristics of scientific knowledge.

KNOWLEDGE/SKILLS	*GRADE 3*	*GRADE 5*	*GRADE 8*	*GRADE 11*
Students will be able to:				
7.1 DESCRIBE THE TENTATIVENESS OF SCIENTIFIC KNOWLEDGE (I.E., NOTION THAT IT IS SUBJECT TO CHANGE, NOT TRUTH IN AN ABSOLUTE AND FINAL SENSE)*		[a]Identify examples of historic changes in scientific knowledge [b]Develop an awareness that science is not absolute	[a]Identify examples of historic changes in environmental, scientific and technological knowledge [b]Identify new circumstances that could interfere with or change scientific explanations	[a]Identify change agents in examples (e.g., discoveries) of historic changes in scientific theories
7.2 EXPLAIN THE IMPORTANCE OF OBJECTIVITY AND SUBJECTIVITY IN SCIENTIFIC THOUGHT, INCLUDING SIMILARITY OF CONCLUSIONS REACHED BY DIFFERENT INDIVIDUALS FROM THE SAME INFORMATION		[a]State conclusions from experimental data	[a]Analyze an experiment or set of rules for the subjective and objective aspects	[a]Create options from collected data to test solutions for a problem
7.3 ANALYZE SCIENTIFIC PREDICTIONS AND EXPLANATIONS FOR THEIR PROBABILITY (I.E., SCIENCE PERMITS REASONABLE BUT NOT CERTAIN PREDICTIONS AND EXPLANATIONS)				[a]Determine if a solution associated with a science/technology/society problem is appropriate

*The additional outcomes for science, both in the knowledge/skill column and the grade level expectancies, are in bold print to distinguish them from the Essential Learning Skills.